

Fig. 1 of Arditi shows a typical response where the microbubble resonant frequency is below the peak response of tissue. A frequency  $f_1$  is near the peak response of a resonant microbubble, and a frequency  $f_2$  is near the peak response from tissue. Using Arditi's values, an echo from contrast would have an amplitude of .011 at  $f_1$  and an echo from tissue would have an amplitude of .0055 at  $f_2$ . This is a 2:1 ratio and a difference of .0055. Arditi wants to enhance this disparity and does so by calculating parameters which are either differences or ratios of the signals at  $f_1$  and  $f_2$ . For the difference  $f_1 - f_2$ , tissue would yield (.004-.0055), or -.0015 and contrast would yield (.011-.003), or .008. The ratio between these two parameters is about 5:1, and the difference is about .0095 which is about twice that of the individual signals alone. With the ratio  $f_1/f_2$ , tissue would yield a ratio of .004/.0055 = .727, and contrast would yield a ratio of .011/.003 = 3.667. These parameters also have a ratio of about 5:1 and a 2.94 difference. Thus, Arditi's images of these parameters would enhance the brightness of contrast relative to tissue in comparison with simply imaging the contrast and tissue signals.

Turning to Claim 1, this claim is seen to recite the use of an image processor which produces image signals which are a blend of proportions of fundamental and harmonic frequency components. These proportions are predetermined to vary with echo signal depth. In Arditi harmonic frequencies are recognized but not used; instead, Arditi uses a band defined by microbubble resonance. The same processing algorithm is used for the entire image, and the parameter values will vary with the relative signal levels in the microbubble resonance band and the tissue frequency band which, as the Examiner notes, leads to fortuitous results. Accordingly it is respectfully submitted that amended Claim 1 is patentable over Arditi. Claim 4 should therefore be patentable by reason of its dependency on Claim 1.

Amended Claim 7 describes an ultrasonic diagnostic imaging system which produces an image which is a variable blend of fundamental and harmonic frequency information. As mentioned above, Arditi disdains the use of harmonics and concentrates on a microbubble resonance band of frequencies. Furthermore, Claim 7 recites the use of a transducer for receiving echoes from tissue in the absence of an ultrasonic contrast agent. As noted above, Arditi teaches that his method is effective only with a contrast agent, as it

provides no advantage in the absence of a contrast agent. Accordingly it is respectfully submitted that amended Claim 7 and its dependent Claims 8-12 are patentable over Arditi. The dependent claims further teach three different types of image formation in three different regions, which is not shown or suggested by Arditi. It is respectfully submitted that the dependent claims are patentable for this further reason.

Amended Claim 13 describes a method for producing an ultrasonic image which is a blend of fundamental and harmonic frequency echo information. As mentioned above, Arditi does not use harmonic frequency information, concentrating instead on microbubble resonant frequencies and a tissue frequency band. The claims which depend from Claim 13 describe the blending of fundamental and harmonic frequency components as a function of time, depth, or location, concepts which are not used by Arditi. For these reasons it is respectfully submitted that Claims 13-16 are patentable over Arditi.

Amended Claim 26 describes a method for producing an ultrasonic image which is a blend of fundamental and harmonic frequency echo information which separates fundamental and harmonic frequency components of ultrasonic echoes. Arditi uses filters to separate a microbubble resonant band from a tissue band. Amended Claim 26 also recites forming signals corresponding to a range of depths which are a varying composition of fundamental and harmonic frequency components with depth. Arditi uses the same combining algorithm for an entire image with no depth variation. For these reasons it is respectfully submitted that amended Claim 26 is patentable over Arditi.

Claims 2, 5, 6 and 27 were objected to, but are allowable if rewritten in independent form. These claims have been rewritten in independent form including the limitations of the base and intervening claims and it is therefore respectfully submitted that these claims are now allowable. It is further respectfully submitted that Claim 3, which depends from rewritten Claim 2, is now allowable by reason of this dependency.

The allowance of Claims 17-25 is gratefully acknowledged.

New Claim 28 describes an ultrasonic imaging method comprising transmitting ultrasonic energy to a target, the ultrasonic energy being characterized by a peak power level in a fundamental frequency band; receiving ultrasonic echo information associated with the transmitted ultrasonic

energy in first and second frequency bands, the first frequency band comprising the fundamental frequency band, the second frequency band comprising a harmonic of the fundamental frequency band and substantially excluding the fundamental frequency band; forming a composite image in response to the received ultrasonic echo information, the composite image comprising spatially distinct near-field and far-field regions, the far-field region emphasizing echo information in the first frequency band and the near-field region emphasizing echo information in the second band. Arditi does not use harmonic frequencies, does not receive a harmonic band which substantially excludes a fundamental band, and does not have near and far field regions emphasizing fundamental and harmonic frequencies. For these reasons it is respectfully submitted that new Claim 28 is patentable over Arditi and the other citations of record.

New Claim 29 describes an ultrasonic imaging method comprising the steps of (a) acquiring fundamental mode ultrasonic image signals and harmonic mode ultrasonic image signals from a scanned region with a transducer; and (b) combining the fundamental and harmonic mode image signals of step (a) to form a composite image, the composite image comprising a first predetermined image region that is modulated primarily as a function of the fundamental mode ultrasonic image signals and a second predetermined image region that is modulated primarily as a function of the harmonic mode ultrasonic image signals. Arditi does not show or suggest forming a composite image of fundamental mode and harmonic mode image signals, nor are there any predetermined image regions which are differently modulated in Arditi. Claim 30 depends from Claim 29 and adds that acquiring harmonic mode image signals is performed in the absence of a contrast agent. For these reasons it is respectfully submitted that new Claims 29 and 30 are patentable over Arditi and the other citations of record.

New Claim 31 describes a medical ultrasonic diagnostic composite image comprising a first predetermined image region modulated primarily as a function of fundamental mode ultrasonic image signals acquired from a portion of a subject; and a second predetermined image region modulated primarily as a function of harmonic mode ultrasonic image signals acquired from a portion of the subject. No predetermined image regions are shown or suggested by Arditi; as the Examiner notes, the processing in Arditi is merely fortuitous. Arditi simply uses the same unvarying algorithm to process an entire image. New Claim 32 depends

from Claim 31 and adds that the harmonic mode image signals are acquired in the absence of a contrast agent. For these reasons it is respectfully submitted that new Claims 31 and 32 are patentable over Arditi and the other citations of record.

New Claim 33 describes an ultrasonic imaging system comprising means for acquiring fundamental mode ultrasonic image signals and harmonic mode ultrasonic image signals from a scanned region with a transducer, and means for combining the fundamental and harmonic mode image signals to form a composite image, the composite image comprising a first predetermined image region that is modulated primarily as a function of the fundamental mode ultrasonic image signals and a second predetermined image region that is modulated primarily as a function of the harmonic mode ultrasonic image signals. Arditi does not show or suggest combining fundamental mode and harmonic mode image signals, nor are there any predetermined image regions which are differently modulated in Arditi. Claim 34 depends from Claim 33 and adds that harmonic mode image signals are acquired in the absence of a contrast agent in the scanned region. For these reasons it is respectfully submitted that new Claims 33 and 34 are patentable over Arditi and the other citations of record.

New Claim 35 describes an ultrasonic imaging method comprising the steps of (a) acquiring fundamental mode ultrasonic image signals and harmonic mode ultrasonic image signals with a transducer; and (b) combining the fundamental and harmonic mode image signals of step (a) to form a composite image, the composite image comprising a first image region that is modulated primarily as a function of the fundamental mode ultrasonic image signals, a second image region that is modulated primarily as a function of the harmonic mode ultrasonic image signals, and a compound image region that is modulated as a function of both the fundamental mode image signals and the harmonic mode image signals, the compound region being intermediate of the first and second image regions. Arditi does not use harmonic mode signals and does not show or suggest the use of a compound image region that is intermediate a fundamental mode modulated region and a harmonic mode modulated region. New Claim 36 adds that the step of acquiring comprises acquiring harmonic mode signals in the absence of a contrast agent. For these reasons it is respectfully submitted that new Claims 35 and 36 are patentable over Arditi and the other citations of record.

New Claim 37 describes a medical ultrasonic diagnostic imaging system adapted to provide a composite image comprising a first image region modulated primarily as a function of fundamental mode ultrasonic image signals, a second image region modulated primarily as a function of harmonic mode ultrasonic image signals, and a compounded region, intermediate the first and second image regions which is modulated as a function of both the fundamental mode image signals and the harmonic mode image signals. Arditi does not show or suggest an image having a compound region that is intermediate a fundamental mode modulated image region and a harmonic mode modulated image region. New Claim 38 adds that the harmonic mode signals are acquired in the absence of a contrast agent. For these reasons it is respectfully submitted that new Claims 37 and 38 are patentable over Arditi and the other citations of record.

New Claim 38 describes an ultrasonic imaging method comprising the steps of (a) acquiring fundamental mode ultrasonic image signals and harmonic mode ultrasonic image signals with a transducer in the absence of an ultrasonic contrast agent; and (b) combining the fundamental and harmonic mode image signals of step (a) to form a composite image, the composite image comprising a first image region that is modulated as a function of the fundamental mode ultrasonic image signals and a second image region that is modulated primarily as a function of the harmonic mode ultrasonic image signals. As mentioned above, Arditi states that his technique is only useful with contrast agents and has no benefit in the absence of a contrast agent. New Claim 39 has utility in tissue harmonic imaging which is beyond the comprehension of Arditi. Accordingly it is respectfully submitted that new Claim 39 is patentable over Arditi and the other citations of record.

New Claim 40 describes a medical ultrasonic diagnostic imaging system adapted to provide a composite image of a subject comprising a first image region modulated primarily as a function of fundamental mode ultrasonic image signals acquired from a first region of the subject, and a second image region modulated primarily as a function of harmonic mode ultrasonic image signals acquired from a second region of the subject in the absence of an ultrasonic contrast agent. As just mentioned, Arditi says that his technique has no significant benefit when imaging in the absence of contrast agents. New Claim 40 describes a composite image have particular utility during tissue harmonic imaging and

it is therefore respectfully submitted that new Claim 40 is patentable over Arditi and the other citations of record.

New Claim 41 describes an ultrasonic imaging system comprising means for acquiring fundamental mode ultrasonic image signals and harmonic mode ultrasonic image signals with a transducer in the absence of an ultrasonic contrast agent, and means for combining the fundamental and harmonic mode image signals to form a composite image, the composite image comprising a first image region that is modulated primarily as a function of the fundamental mode ultrasonic image signals and a second image region that is modulated primarily as a function of the harmonic mode ultrasonic image signals. As mentioned above, Arditi states that his technique is only useful with contrast agents and has no benefit in the absence of a contrast agent. New Claim 41 has utility in tissue harmonic imaging which is beyond the comprehension of Arditi. Accordingly it is respectfully submitted that new Claim 41 is patentable over Arditi and the other citations of record.

In view of the foregoing amendments and remarks, it is respectfully submitted that Claims 1, 3-4, 7-16 and 26 are patentable over Arditi and that Claims 2, 5, 6, and 27 are now in allowable form. It is therefore respectfully requested that the rejection of Claims 1, 3-4, 7-16 and 26 under 35 U.S.C. §103(a) be withdrawn. It is further respectfully submitted that newly added Claims 28-41 are patentable over the citations of record. It is thus respectfully requested that these new claims be allowed and the case passed on to issuance.

In light of the foregoing amendment and remarks, it is respectfully submitted that this application is now in condition for allowance. Favorable reconsideration is respectfully requested.

Respectfully submitted,

DAVID N. ROUNDHILL ET AL.

By:

W. Brinton Yorks, Jr.  
W. Brinton Yorks, Jr.  
Reg. No. 28,923

ATL Ultrasound, Inc.  
22100 Bothell Everett Highway  
P.O. Box 3003  
Bothell, WA 98041-3003  
(425) 487-7152  
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